May 9, 2017

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Re: **Oral *Ex Parte* presentation in RM-11681 "Petition [by Ligado Networks] for Rulemaking to Allocate the 1675-1680 MHz Band for Terrestrial Mobile Use"; IB Docket No. 12-340 "LightSquared Request to Modify Its ATC Authorization."; IB Docket No. 11-109, Regarding the Ligado Modification Applications.**

Dear Ms. Dortch:

On May 4, 2017, the following representatives from industry and academia of the weather, meteorological satellite, satellite ground systems and transportation communities met with Julius Knapp, Ronald Repasi and Paul Murray from the Office of Engineering and Technology, and Charles Mathias from the Wireless Telecommunications Bureau:

- Mr. Brett H. Betsill, Radio Frequency Equipment Design Engineer and Ground Station Manufacturer, President, Microcom Design, Inc., Hunt Valley, Maryland
- Dr. Jordan Gerth, Associate Researcher, Space Studies and Engineering Center (SSEC), University of Wisconsin, Madison, Wisconsin
- Dr. Brian Kopp, Assistant Professor of Electrical Engineering, University of North Florida, Jacksonville, Florida
- Ms. Renée A. Leduc Clarke, Founder and Principal, Narayan Strategy, a weather and climate policy consulting firm, Washington, D.C.
- Mr. Roger Madden, Principal Engineer, Kapsch TrafficCom North America (Consultant to Florida Department of Transportation)

The primary purpose of this meeting was to present information on how real-time water and weather information received directly from the GOES satellite in 1675-1695 MHz is used by the hydrometeorological, transportation and emergency management communities and to discuss concerns regarding the proposal to share 1675-1680 MHz with strong terrestrial transmitters proposed by Ligado Networks.

Microcom Design, Inc., the University of North Florida, the Florida Department of Transportation and the University of Wisconsin's SSEC, in addition to representatives of the American Weather and Climate Industry Association (AWCIA)[1], the International Association of Emergency Managers

[1] June 17, 2016 Comments in RM-11681 of the AWCIA, https://ecfsapi.fcc.gov/file/106190767602388/AWCIA%20FCC%20letter-061716.pdf

(IAEM)[2] and Aviation Spectrum Resources, Inc. (as a member of the Joint Aviation Parties)[3], who were unable to attend the briefing in person, have filed multiple letters in the RM-11681 and the 12-340 proceedings, and the information contained in these letters were referenced in the briefing. For example, participants referenced how science data and imagery from GOES (and the currently deploying GOES-R series) satellites are used by Federal and non-Federal meteorologists, hydrologists and emergency managers to protect life and property across the U.S. and its territories and support the economy.

The National Oceanic and Atmospheric Administration (NOAA) and its broad community of users have already shown commitment to freeing up spectrum for diverse uses in the past few years[4]. **The design of NOAA's new GOES-R series of satellites was changed in 2011 to move out of AWS-3 spectrum in 1695-1710 MHz pushing it below 1680 MHz, placing low powered satellite downlinks in close proximity to strong terrestrial services, while effectively constricting the amount of bandwidth available to future GOES satellites.** Although the GOES-R series will produce exponentially more real-time data than existing systems on orbit, additional spectrum sharing in this band would handicap users desiring to obtain GOES-R data. In addition to a recent move involving the redesign of National Weather Service (NWS) radiosondes, this proposed action would be a third major impact in recent years on the hydrological and meteorological forecasting communities due to spectrum changes.

Use of GOES Data by U.S. Industry

Many industries rely on real-time information from GOES satellites to inform their decisions and warn their users, customers and stakeholders of weather and hydrological hazards. For example, AWCIA is a group of companies providing mission critical weather information to support the public and a broad range of industries, including aviation, rail and other transportation, shipping, energy, insurance, retail, agriculture, health care and many more. The members of the AWCIA also provide value-added, real-time information and support to the public sector including the Commerce, Transportation, Defense and Agriculture Departments, and many state and local governments. For example, AccuWeather, a member of AWCIA, serves two billion weather consumers worldwide each day with its forecasts, which includes tens of millions of people in the

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[2] June 20, 2016 Comments in RM-11681 of International Association of Emergency Managers, https://ecfsapi.fcc.gov/file/10620767623947/IAEM-USA%20Comment%20to%20FCC%20on%20NWS%20spectrum%20RM11681.pdf

[3] August 12, 2016 Reply Comments in RM-11681 of Airlines for America, Aviation Spectrum Resources, Inc., Cargo Airlines Association, Delta Airlines, Federal Express, Helicopter Association International, National Air Transportation Association, and National Business Aviation Association ("Joint Aviation Reply Commenters") https://ecfsapi.fcc.gov/file/1081211620678/Joint%20Aviation%20Reply%20Comments%208%2011%202016.pdf

August 17, 2016 Ex Parte Presentation of Airlines for America, Aviation Spectrum Resources, Inc., Aerospace Industries Association, and Helicopter Association International in IB Docket Nos. 11-109 and 12-340 https://ecfsapi.fcc.gov/file/108171106228817/Aviation%20Spectrum%20Resources%20et%20al%20Ex%20Parte%208-17-16%20Final.pdf

[4] NOAA operates in 20 MHz of Federal use spectrum (1675-1695 MHz) and no longer has exclusive use to the additional 20 MHz formerly for Federal use; the AWS-3 spectrum in 1695 – 1710 MHz and the 5 MHz of spectrum (1670 – 1675 MHz) auctioned in 2002 and now leased by Ligado Networks. Yet, from GOES to GOES-R reflects about 15 times increase in data for the broadcast downlinks using this spectrum.

U.S. each day who rely on their mobile applications, websites, and radio or television forecasts to receive important weather updates.

If approved, Ligado's proposal to share 1675-1680 MHz likely will only allow for limited protection zones to be established for select Federal downlink sites. The protection zones defined for NOAA so far (for AWS-3) are likely not sufficient in size to avert interference, especially at Wallops Island, VA, which is the primary ground station for the GOES and GOES-R programs, as highlighted in previous letters and in Congressional testimony.[5] In addition, as proposed, 1675 – 1680 MHz spectrum sharing does not accommodate protection zones for all other agencies within the federal, state or local governments or for industry or academia. **Such a lack of protection zones is a significant threat to major components of the U.S. weather, water and related environmental forecasting enterprise that provide crucial information to citizens for life and safety and the economy.** When spectrum sharing of such different services occurs in the same band, appropriately sized protection zones, which would prohibit installation of commercial towers in proximity to sensitive satellite ground stations, is the only viable mitigation method.

The weather, water and climate community coordinates substantially across public, private and academic lines to maximize their collective expertise to advance weather and water forecasting and related emergency management activities across the country and the world as encouraged and supported by numerous expert studies, particularly the National Research Council.[6] **Public-private-academic partnerships have been established as crucial to enhancing warning times in advance of severe storms and crucial to coordinating information to inform accurate evacuation zones for hurricane prediction.** Without consistent and reliable access to real-time information from the GOES and GOES-R satellites and its data collection system across the weather and water enterprise, predictions will no longer keep improving as they have,[7] more lives will be lost and businesses will be more seriously impacted by weather and water related hazards. Research has estimated the annual value of existing weather forecasts to households at $31.5 billion in 2006.[8]

The Value of GOES-R, GRB, DCS and EMWIN – Are there viable non-satellite alternatives?

The GOES-R series of satellites is comprised of four spacecraft, with the first launched in November 2016 (now called GOES-16), with the second scheduled to be launched in 2018. **These satellites have a projected lifetime on orbit extending out to 2036, so this is not a system that will be replaced quickly with its system to relay real-time data via 1675-1680 MHz.** The satellites are already designed with their ground systems and a second redesign would come at significant cost and schedule delay (making such a change impractical if not impossible), and the already launched GOES-16 satellite cannot be modified on orbit, nor can GOES-S (the future

[5] An Overview of the Budget Proposal for the National Oceanic and Atmospheric Administration for Fiscal Year 2017. Environment Subcommittee of the U.S. House of Representatives Committee on Science, Space and Technology. 114th Congress. 16 March 2016. (Hearing dialogue with Rep. Jim Bridenstine (R-OK) and Under Secretary Kathryn Sullivan (NOAA Administrator)).

[6] National Research Council, "Fair Weather: Effective Partnerships in Weather and Climate Services", 2003 https://www.nap.edu/read/10610/chapter/1

[7] National Research Council, "Weather Services For The Nation – Becoming Second to None," 2012. https://www.nap.edu/catalog/13429/weather-services-for-the-nation-becoming-second-to-none

[8] Lazo, J.K., et. al., "300 Billion Served: Sources, Perceptions, Uses, and Values of Weather Forecasts," Bulletin of the American Meteorological Society," 90 (6): 785-798.

GOES-17) since it is already being tested for launch. Remaining satellites have been designed and are in various stages of development, with key units and subsystems already procured. Given the billions of taxpayer dollars that were invested in this new satellite technology to enhance forecasting, to diminish access to its real-time data due to interference would prevent the nation from getting its appropriate return on its investment, while also diminishing the quality of hydrometeorological forecasts. While the next-generation system after the GOES-R series will likely start to be initially designed in about a decade, the nation will continue to rely on the operational GOES-R satellites for real-time severe weather prediction predominantly until at least 2036.

The Data Collection System (DCS) on the GOES-R satellite series provides real-time relay of data from over 27,000 sensors within view of the GOES-R satellites, with that number expected to nearly double in the next few years. These sensors provide information about many applications including stream, river, lake and tidal gage data for warning of flooding and tsunamis, protection of coastal and riverbank communities, and for maritime operations. The DCS also relays wildfire weather data essential for management of wildfire fighting and protection of the firefighters and property under rapidly changing conditions. DCS data is relayed via GOES-R so that all uplinks are immediately sent down to receive stations within the 1675- 1680 MHz spectrum (with the uplinks reporting at different intervals based on application, ranging from every minute to every hour based on conditions). The satellite is a direct transpond (e.g. turnaround) from the uplink data to the downlink data; any interference to the downlink in 1675 – 1680 MHz would result in the complete loss of the DCS sensor data.

The GOES-Rebroadcast (GRB) downlink, provides a complete copy of all the full resolution, calibrated, near-real time set of the science data from all instruments on the spacecraft (i.e., full resolution instrument data with radiometric and geometric correction applied to produce parameters in physical units known as Level 1b and some derived variables known as Level 2+ data). **GRB is the fastest way to obtain this data with high availability. It avoids internet connectivity given the internet's lack of reliability in severe weather conditions.**

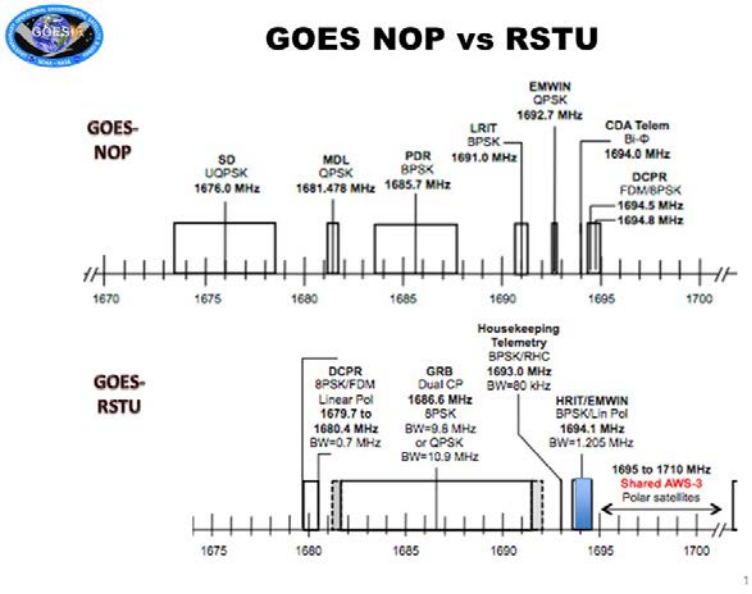
GRB also feeds NOAA's own delivery network, the Product Distribution and Access (PDA) system. PDA is a redundant operational delivery and dissemination system, located at NOAA's Satellite Operations Facility in Suitland, Maryland, that users access via internet. PDA data is available to a limited array of users at least one minute later than GRB, subject to internet outages, delays and connection capacity. In addition to the need from many users for real-time imagery data (detailed below), information from the new Geostationary Lightning Mapper sensor (GLM) on GOES-16 has a data latency of 20 seconds. **These are the clearest examples that PDA (and most certainly the Ligado proposed content delivery network (CDN)) does not fulfill the needs of users requiring the most real-time data.** PDA also provides the source data for the publically available NOAA archive, Comprehensive Large Array-Data Stewardship System (CLASS) that serves as an electronic library of NOAA environmental data. CLASS allows for public access to NOAA data and science information, including GOES and GOES-R. (See https://www.class.ngdc.noaa.gov/saa/products/welcome)

The GRB provides an important primary source of GOES-R data for many Federal and non-Federal users. **Not only does GRB disseminate data quickly, which is a necessary capability for products with low latency requirements, but it provides a backup capability in the event**

of PDA failure. The PDA system is not backed up for all GOES-R products[9] but just a subset of images; therefore the failure of the primary PDA system or the terrestrial connectivity to the PDA system, would leave a PDA-sourced operational user without access to GOES-R data unless they had access to the GRB broadcast.

The remaining NOAA GOES-R downlink, just above GRB in the spectrum, is the High Rate Information Transmission / Emergency Managers Weather Information Network (HRIT/ EMWIN). **EMWIN is a direct service that provides users (especially in emergency management) with weather forecasts, warnings and graphics, and other information directly from the National Weather Service (NWS) in near real time.** The GOES EMWIN relay service is one method to obtain these data and display the products on the user's personal computer. In the event of a severe weather event, such as a hurricane or tornado, EMWIN can be the only available source of these critical weather products for emergency managers and decision makers. EMWIN is designed for receipt under high-wind and precipitation conditions from a small, mesh antenna, feeding a battery-powered fixed or transportable personal computer. The HRIT service provides broadcast of low-resolution GOES-R satellite imagery data and selected products to remotely located user HRIT terminals. These data originate from NOAA's Environmental Satellite Processing Center and are comprised of satellite imagery; derived products from GOES-R and polar satellite programs; watches, warnings, forecasts, graphics, and other hydrometeorological products originating in the National Weather Services; and products derived from DCS data.

By their nature, HRIT/EMWIN receivers have typically had very little excess link margin. Past designs did not have adequate margin to allow insertion of a filter into the RF chain. Increasing the antenna size or frequency band, which would significantly change the current mesh antenna, might not function in the high wind, high precipitation environment associated with severe weather. **During natural disasters often electricity, internet connectivity and even wireless communications systems have failed, which would prevent a terrestrial solution from providing the data which can be most reliably obtained directly from GOES-R satellite broadcasts.** This is why HRIT/EMWIN is so important to the broader weather enterprise, especially for emergency managers in the most severe weather situations.



In summary, **DCS, GRB and HRIT/EMWIN will all be subject to interference in the spectrum sharing scenario proposed by Ligado.** Specifically, DCS will face in band interference, while GRB and HRIT/EMWIN will be susceptible to adjacent band interference. This is also described in the figure adjacent, as distributed at the briefing. Such interference would be an

[9] NOAA backup sites provide for GOES-16 Key Performance Parameter (KPP) data and not the full product set. For the full product set, a user must either access the primary PDA site or receive data directly into a GRB ground station.

unacceptable risk to life and property and our nation's economy given the incredible established value of this information to weather and water forecasting.

The prototype CDN described by Ligado as an alternative to the downlink of real-time data from GOES satellites via GRB, DCS and HRIT/EMWIN has been determined to be insufficient to fulfill the weather and water community's needs for data latency and reliability. As defined in a recent letter,[10] the weather and water community (which includes public, industry and academic stakeholders) require a data reliability standard of 99.988 percent for GOES rebroadcast services (GRB), which only allows for five minutes of downtime each 30 days, and requires any outages to be resolved within five minutes. The service level agreements available through most cloud-based services typically allow for 50 minutes of downtime every 30 days, and frequently fail to meet that standard. If those 50 minutes per month happen in the midst of a major severe weather event, such a lack of real-time data to forecasters can mean the difference between a family getting a warning of an incoming tornado, or not. Those cloud-based service level agreements often do not include the impacts from internet connectivity which carries the information from the cloud-service access point to a user's premises and reduces the overall availability. Some internet services have minimum response times for repair, stated in hours, which add to the duration of outages.

When weather forecasters use GOES data to predict severe weather, particularly from the new GOES-16 (previously called GOES-R) launched last year, they look at the data arriving in real time every 30 seconds to closely observe changes in clouds that can indicate the development of severe storm activity. If that information comes minutes late, its value is significantly degraded, which impacts the timeliness of warnings, limiting the time the public has to respond to weather hazards. The information stream is very large – coming at gigabytes at a time – and the Ligado proposed CDN will not be sufficient to accommodate this data and its required latency for operational use, as has been shown in a similar CDN developed by the Japanese government to transmit information from its Himawari-8 satellite, which includes similar technology to that on the GOES-R series of satellites.[11]

Diverse Examples Show the Breadth and Depth of Negative Impact of Sharing of 1675-1680 MHz

Transportation and Storm Evacuation:

One example of real-time DCS use that will suffer if required to use a Ligado proposed CDN is by the Florida Department of Transportation (FDOT),[12] which was also detailed in a FCC comment in June 2016.[13] The FDOT has installed Earth stations that downlink real-time wind speed data that is uplinked from anemometers installed on highway bridges, particularly those on drawbridges that lead to boundary islands on the coast of Florida. **The FDOT system provides data to the public**

[10] April 10, 2017 written ex parte filing in RM-11681 from the American Meteorological Society, the American Geophysical Union and the University of Wisconsin – Madison, Space Science and Engineering Center. See https://ecfsapi.fcc.gov/file/104132285323927/FCC_AMS_AGU_SSEC_Feedback_April_2017.pdf

[11] 20 June 2016 Filing in RM-11681 from Dr. Henry E. Revercomb and Jerrold Robaidek of the Space Science and Engineering Center, University of Wisconsin-Madison. See https://ecfsapi.fcc.gov/file/1062147369994/FCC%20response.pdf

[12] https://ops.fhwa.dot.gov/weather/best_practices/casestudies/008.pdf

[13] https://ecfsapi.fcc.gov/file/1072020498400/ligado%20reply%20comments%20160619.docx

safety community to help them decide when to close and reopen bridges and highways during severe weather events. When the GOES-16 satellite becomes operational in November 2017, the DCS downlink will move to 1679.7 - 1680.1 MHz, just as hurricane season is ending. Their use of an Earth station to obtain real-time data transmitted over DCS is critical for FDOT users to ensure the data can be received without the use of the internet or other commercial telecommunications services that are often compromised during a severe weather event such as a hurricane. Similar arguments about the importance of not relying on the internet in emergency situations were made by users of EMWIN in comments to the FCC in June 2016.[14]

This FDOT project is the first of its kind and has so far proved successful, in particular during the 2012 hurricane season when it helped inform public safety officials in real time what the wind conditions were on the bridges in and around Jacksonville, Florida. **The FDOT project has been recognized by the Federal Highway Administration as a best practice for road weather management.** The FDOT has expanded their project and has begun to install 25 NOAA GOES DCS wind speed sensors along the Florida Keys to assist with real-time traffic management and evacuation planning in that vulnerable area. Other states have expressed an interest in this project and there is potential for additional Earth station installations on a national level, wherever there is concern that commercial telecommunication services may fail during severe weather or another disaster.

Wildfire Monitoring and Management:

There are approximately 2,300 Remote Automatic Weather Stations (RAWS) deployed by the National Interagency Fire Center (NIFC) in Boise, Idaho, which are strategically located in fire prone areas throughout the U.S. and report their data via DCS. These stations monitor the weather and provide localized data that assists wildland fire agencies to monitor fire danger, In addition, there are also 42 portable RAWS units that can be deployed to an incident to augment on-site forecasts in real-time. The data from all of these RAWS gets downlinked via a DCS ground terminal to the NIFC (which is managed in partnership by eight different federal agencies from the Agriculture, Commerce and Interior Departments) via DCS. The NIFC recognizes that weather data is critical to predicting fire behavior, which is important to effective fire management of all kinds (suppression, prescribed burning, wildland fire use, etc.).[15] **The data is crucial to track winds and soil moisture conditions so that wildfire weather managers can make decisions that best protect the life of firefighters and protect lives and property.** Remote sensors relayed via GOES were also deployed at Ground Zero just after September 11, 2001, and after major oil spills in the Gulf of Mexico to perform air and water quality measurements.

Volcanic Ash Detection for Aviation Safety:

Another critical and time sensitive application of real-time GOES data is the detection of volcanic ash clouds. As highlighted in filings by the Joint Aviation Partners and the Geospatial Information Network of Alaska (GINA) and in refereed journals, **volcanic ash can be catastrophic to aircraft engines, causing them to stall or lose power suddenly in flight**. Active volcanoes are located in the so-called Pacific Ring of Fire, which stretches around the Pacific Ocean, including, notably, Alaska and the western U.S.

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[14] 20 June 2016 Filing in RM-11681 from the U.S. Council of the International Association of Emergency Managers: https://ecfsapi.fcc.gov/file/10620767623947/IAEM-USA%20Comment%20to%20FCC%20on%20NWS%20spectrum%20RM11681.pdf

[15] NIFC https://www.nifc.gov/aboutNIFC/about_main.html

With pilots traveling at approximately 500 miles per hour, potentially toward an ash cloud, warnings to avoid such fatal hazards need to be communicated to pilots as soon as available. Ash clouds are difficult to distinguish from weather clouds, hence, the new resolution and enhancements in the GOES-R imager can greatly enhance the identification and detection of volcanic ash clouds. Volcanic ash detection is complicated by the unpredictable nature of volcanic activity, and the ability of the earth's wind circulation systems to spread ash and gas over large distances quickly. **Meteorologists monitoring volcanically active areas require the highest resolution imagery that is available in a real-time and reliable fashion.** This means for GOES satellite data in the GOES-R era they must receive GRB, which is the only source for the highest resolution over the ocean imager scans, at low latency and high reliability. Many commercial airlines and general aviation aircraft routinely fly in the areas impacted and need this product to understand whether they can complete that flight safely.

The United States hosts two of the world's nine Volcanic Ash Advisory Centers (VAAC), one in Washington and another in Anchorage. The Alaska forecast and warning center protects all aviation that passes through one of the most active volcanic regions in the world, and Anchorage is the second busiest air cargo hub in the U.S. **Considering air routes, nearly all flights to/from northern Asia and the United States traverse the Alaska coverage region, and right over many of these volcanoes, carrying about 10,000 people per day with up to 50,000 flights per year.** Alaska-based real-time GOES users, particularly the Anchorage VAAC would be severely compromised if forced to only rely on internet sources of data. Alaska is dependent on a handful of subsea fiber optic cables for connection to the global communications network that are subject to significant outages that are much more common than in the CONUS.

Tsunami Warnings:
NOAA's National Ocean Service operates tidal gages that support tsunami warnings along the coasts of the United States. Tsunamis pose a significant threat to coastlines around the world. **Water level observations at coastal tide stations comprise a critical component of an effective tsunami warning system.** NOAA operates tide stations on all U.S. coasts in support of tsunami warning, and it established 16 new high-priority tide gage systems in Alaska, the Pacific Islands, the West Coast, and the Caribbean, increasing the geographic coverage of water level observations in tsunami-vulnerable locations. Each station collects and transmits critical tsunami warning data to regional centers using DCS.[16]

Further Proceedings Related to 1675-1680 MHz Should be Halted Until Further Research is Completed

The participants in the briefing stated clearly that 1675-1680 MHz should not be shared in the short term and such sharing should not be considered further until additional research is completed, including the user research to be conducted by NOAA, requested under the Spectrum Pipeline Act of 2015, over the next two years. **This means that any consideration of moving forward with a Notice of Proposed Rulemaking (NPRM) should be halted until this research is complete and briefed to all relevant stakeholders.**

[16] https://acwi.gov/hydrology/stiwg/stiwg_dcs_reliance_and_preservation.pdf

The user research requested under the Spectrum Pipeline Act will be important to identify the numbers and locations of users and how they access real-time GOES information. In the briefing there was discussion about numbers of Earth stations, but those numbers were approximate and only based on the knowledge of individual manufacturers, which is not often disclosed given the competitive nature of this industry. Fundamentally, registration of such data receivers is not required. It has been established U.S. government policy in multiple Administrations that such environmental satellite data is in the public interest and should be openly available to those with the capability to receive it.[17] While we understand the FCC was hoping to gain universal insight into real-time users through the public comment period in 2016, that was likely not realistic since most users of GOES information do not track ongoing FCC proceedings and may consider their investment in a GRB receive system, in particular, a competitive advantage that they may not want to disclose publicly. **However, nearly 70 diverse industry, non-profit, international, and state and local government stakeholders did weigh in with their detailed comments as users in the public comment period, which far surpassed the number of commenters supporting Ligado's proposal.**

The recent launch of GOES-16 and the upcoming 2018 launch of GOES-S are the first two U.S. geostationary environmental satellites with new technology to come on orbit in nearly 30 years. This is not the time to be considering limiting the capabilities of this technology when so many years of effort and billions of taxpayer dollars have been devoted to enhancing forecasts to save lives and property, and support the economy.

In addition, the briefing participants noted dismay with the ongoing activities and communication of Ligado throughout this process. While the community has welcomed them and sought their feedback and dialogue,[18] Ligado has yet to reflect the community's technical evidence and forecasting concerns in their communications. Instead, Ligado has dismissed the needs for real-time information of industry and academic partners in the community, marketing a CDN that has been repeatedly noted to be insufficient to continue to advance environmental forecasting for the nation. If Ligado is unable to communicate in a transparent and cooperative way now, the community is very concerned that moving forward with an NPRM will further degrade the quality of Ligado's engagement.[19]

Sharing the 1675-1680 MHz radio spectrum poses significant risks to the nation's forecast, communication, and warning capabilities for extreme events. The potential degradation in this capability would create risks to public health and safety, private sector initiatives, and

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[17] "Publicly funded Earth observations which are integrated, open and freely available are critical to understanding complex social dynamics such as human influence on food and water resources, energy security, and climate change, and their resulting impacts on societal health and well-being. These data and observations also support private sector products and services, enhancing productivity, employment, and the economy."
https://obamawhitehouse.archives.gov/administration/eop/ostp/nstc/committees/cenrs/usgeo

[18] Representatives from Ligado were invited and attended the American Meteorological Society (AMS) Summer Community Meeting in Tuscaloosa, Alabama in July 2016 and the AMS Annual Meeting in Seattle, Washington in January 2017.

[19] NOAA also apparently has existing radio frequency interference problems, stemming from the existing Ligado transmissions in 1670 – 1675 MHz. If NOAA facilities are getting interference, and they are protected by provisions in past spectrum auctions, then how will placing Ligado on top of DCS and closer to the remaining GOES-R downlinks be sustainable? See https://www.nesdis.noaa.gov/content/noaa's-environmental-observations-spectrum-matters

scientific advancement. Significant industry segments and members of the general public are protected from extreme weather by NOAA data and products (public and private-sector created), which utilize the 1675 – 1695 MHz spectrum and have a high likelihood of interference from the Ligado proposals in 1675 – 1680 MHz.[20] Before any further efforts are made toward a notice of proposed rulemaking in this matter, additional research that is both independent and comprehensive is required.

Submitted by the briefing participants from industry and academic partners of the hydrometeorological community.

[20] Ligado indicates they would supply data to trains, helicopters, aircraft and other industrial entities offering so called - Internet of Things services. Yet some of those same services are weather sensitive, requiring the meteorological and hydrological warnings sent via 1675 – 1680 MHz and adjacent bands for their operational needs. Helicopters who require precise location data for short notice flights from hospital helipads or from off-shore facilities supporting energy exploration require up to date weather information. By Ligado offering commercial services in this particular spectrum band, instead of in different spectrum, the customers may be more impacted by weather or the potential lack of timely weather or water warnings "in exchange" for their new commercial services.